- 1 -

Docket: 740756-001678

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	Art Unit: 2871
Akira MASE	)	Examiner: J. Dudek
Serial No. 08/962,448	)	
Filed: October 31, 1997	)	
For: A DEVICE HAVING AN IMPROVED	)	
CONNECTIVE STRUCTURE	)	
BETWEEN TWO ELECTRODES	)	

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with The United States Postal Service with sufficient postage as First Class Mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20131, on __________

____

SUBMISSION OF ENGLISH TRANSLATION OF PRIORITY DOCUMENT

Honorable Commissioner for Patents
Washington, D.C. 20231

Sir:

Further to the Amendment submitted on June 20, 2001, submitted herewith is an English Translation of Japanese Priority Document No. 1-232308 with Declaration. Consideration is respectfully requested.

Respectfully submitted,

Eric J. Robinson
Reg. No. 38,285

Nixon Peabody LLP
8180 Greensboro Drive, Suite 800
McLean, Virginia 22102
(703) 790-9110

COPY

Docket No. 0756-1678

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)
Akira MASE	)
Serial No.: 08/962,448	) Group Art Unit: 2871
Filed: October 31, 1997	) Examiner: D. Dudek
For: LIQUID CRYSTAL DEVICE AND	)
MANUFACTURING METHOD THEREFOR	)

VERIFICATION OF TRANSLATION

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

I, Satomi Yumoto, B-310, 304-1, Hase, Atsugi-shi, Kanagawa-ken 243-0036 Japan, a translator, herewith declare:

that I am well acquainted with both the Japanese and English Languages;

that I am the translator of the attached translation of the Japanese Patent Application No. 1-232308 filed on September 6, 1989; and

that to the best of my knowledge and belief the following is a true and correct translation of the Japanese Patent Application No. 1-232308 filed on September 6, 1989.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: this 27 day of June, 2001

Satomi Yumoto

Name: Satomi Yumoto

Patent Application

(¥14,000) September 6, 1989

Attention: Commissioner, Patent Office

1. Title of Invention

A METHOD OF MANUFACTURING LIQUID CRYSTAL ELECTRO-OPTICAL DEVICE

2. The Number of Claims 2

3. Inventor

Address 398, Hase, Atsugi-shi, Kanagawa-ken
c/o Semiconductor Energy Laboratory Co., Ltd.

Name Akira MASE

4. Applicant

Address 398, Hase, Atsugi-shi, Kanagawa-ken

Name Semiconductor Energy Laboratory Co., Ltd.

Representative Shunpei YAMAZAKI

5. List of Attachment

(1) Specification 1

(2) Drawing 1

(3) Duplicate 1

SPECIFICATION

1. TITLE OF THE INVENTION

A METHOD OF MANUFACTURING LIQUID CRYSTAL ELECTRO-OPTICAL DEVICE

2. WHAT IS CLAIMED IS:

1. A method of manufacturing liquid crystal electro-optical device comprising:

forming a conductive thin film on the surfaces of a substrate;

disposing a liquid crystal between a pair of said first and second substrates wherein a circuit is formed by cutting said conductive thin film through exposing laser light;

a process of manufacturing a liquid crystal panel;

a process of making a wiring on a third substrate which is not a substrate manufactured a liquid crystal panel;

a process of connecting a semiconductor chip for driving a liquid crystal with the wiring on said third substrate;

a process of connecting by aligning a wiring on a liquid crystal panel and the corresponding said third wiring with an anisotropic conductive ultraviolet light curable adhesive therebetween and exposing ultraviolet light under pressure.

2. The method of claim 1 wherein ultraviolet light curable adhesive includes a mixture of at least first particles with conductive surface and second particles a little finer than the first particles.

3. DETAILED DESCRIPTION OF THE INVENTION

[DESCRIPTION OF THE PRIOR ART]

Due to its merits, that are lighter weights and less electrical consumption power than the prior display devices, many appliances such as electric calculators, watches, word processors and pocket television systems are provided with liquid crystal electro-optical devices.

The driving circuit of a liquid crystal of liquid crystal electro-optical devices has been formed in a separate printed board made of a glass epoxy substrate in which a semiconductor device such as a packaged IC is mounted. In this case, the electric connection is made through FPC (Flexible Print Circuit) for example, between an electrode of the printed board mounted the packaged IC and an electrode formed in a liquid crystal panel.

Recently, TAB (Tape Automated Bonding) has been used. In accordance with this method, semiconductor chips provided with solder bumps on their contact pads are mounted on and electrically connected with Cu electrodes and the like formed on a polyimide film by face-down bonding (ILB: Inner Lead Bonding), and then said film are coupled with an electrode formed on a liquid crystal panel (OLB: Outer Lead Bonding).

A semiconductor chip can be mounted directly on the substrate of a liquid crystal panel. For example, on the substrate to form a liquid crystal panel, an electrical wiring for putting a signal in a semiconductor chip and an electrical wiring for supplying an output signal from a semiconductor chip to an electrode of the displaying part of a liquid crystal panel have to be formed in advance. And then, said wirings are wire-bonded

with semiconductor chips by means of Au wiring, or are face-down bonded by means of bumps formed in the part of pads of the semiconductor chips.

[PROBLEMS OF THE PRIOR ART]

There are some shortcomings, however, in the above conventional technique. In the case that the packaged IC are mounted on the printed substrate of a glass epoxy and said printed substrate are connected with a liquid crystal by using FPC, because not only the packaged IC is too large but also it is put on the printed substrate of a heavy glass epoxy, the advantage of light weights claimed by a liquid crystal electro-optical device is largely diminished. Furthermore, because of using FPC for connecting the printed substrate with a liquid crystal panel, two sites of connection at both ends of the FPC are needed for the printed substrate and a liquid crystal panel. Therefore, the double connection of the number of wirings for connection is needed and the yield also goes down.

And, general connection of FPC by thermo compression bonding can cause FPC to expand thermally in connection and cause pre-heated alignment to shift slightly in heating. This phenomenon appears clearly in increasing the number of wirings in a sheet of FPC, and many FPC are needed in manufacturing a liquid crystal panel with many wirings. Consequently, expense gets greater as it requires a great deal of time and labor for alignment.

Further, though a glass substrate is usually used for a liquid crystal panel, in this case, the difference between the FPC and the glass substrates in thermal expansion coefficient

becomes a cause of stress and a lowering of reliability by a change of temperature even if it can be connected in bonding.

In the TAB method, it improves in lightness because it does not need the printed substrate to dispose a semiconductor device for driving a liquid crystal, but it is undesirable because polyimide tape is so expensive.

In addition, in the use of polyimide tape, the above-mentioned problem of thermal expansion arises.

In the case of the mounting a semiconductor chip on the substrate to mount a liquid crystal panel, the yield of production of a liquid crystal electro-optical device is equal to the product of the yield of manufacturing a process of connecting semiconductor chips with wirings and the yield of liquid crystal panels, and therefore it is undesirable because the decrease of the whole yield is substantial.

[STRUCTURE OF INVENTION]

To solve the above-mentioned problem, the present invention is characterized as follows; an electrode formed on a pair of the substrates to consist of a liquid crystal panel of a liquid crystal electro-optical device is formed by cutting a conductive film through exposing laser light after forming a conductive thin film on the surface of a substrate; a semiconductor chip for driving a liquid crystal is mounted on a third substrate which is neither a pair of a first nor a second substrate; the connection is made by aligning a wiring on the substrate mounted a semiconductor chip and the corresponding wiring on the substrate consisted of a liquid crystal panel with an anisotropic conductive ultraviolet light curable adhesive therebetween and exposing

ultraviolet light under pressure.

Particularly in the present invention, in the case that a conductive particles and smaller particles are mixed in said ultraviolet light curable adhesive, it is desirable because the yield of wiring connection gets much better.

In the present invention, not a packaged semiconductor device but a semiconductor chip is used for driving a liquid crystal, so that the printed substrate of a glass epoxy to mount said chip is not needed and therefore the peculiar advantage of a liquid crystal electro-optical device, in lightness, is not diminished.

And to connect a liquid crystal panel with the part of driving circiut without using FPC enables to remove the above-mentioned problems, that is, the number of connection becomes the double of the number of wirings and thermal expansion of FPC.

Further, in the present invention, an expensive polyimide tape in such as TAB method is not required, so that a liquid crystal electro-optical device can be manufactured at a low price.

Furthermore, in accordance with the present invention, the substrate to form a liquid crystal panel and the substrate to mount a semiconductor chip are manufactured separately, and therefore a semiconductor chip is connected with a wiring on the substrate and then a process of electrical test regarding connecting chips with wirings can be prepared before connecting with a liquid crystal panel, and consequently imperfect chips in connection is not needed to connect with a liquid crystal panel, as a result the yield is expected to substantially increase.

Also, particularly in the present invention, the electrode of a liquid crystal panel is manufactured by cutting a conductive film with laser light, it is easier to make the interval of electrodes small than the case of manufacturing by photolithography. But if the substrate mounted a semiconductor chip is connected with this liquid crystal panel with little interval of electrodes by using FPC, it is undesirable because thermal expansion such as above-mentioned arises to short adjacent wirings. Accordingly, only the present invention, which comprises a process of forming an electrode with laser light and a process of connecting a wiring on the substrate mounted a semiconductor chip with a wiring on a liquid crystal panel by using ultraviolet light curable adhesive, can make the interval of electrodes of a liquid crystal panel smaller, in other words can make aperture ratio of a liquid crystal panel larger, and further can solve the above-mentioned problems.

Hereinafter, the present invention will be specifically described.

[EMBODIMENT 1]

The present embodiments are explained by using Figs. 1(a), (b), 2 and 3.

First, a liquid crystal panel is formed.

As a first substrate (1), a sodalime glass substrate of 1.1mm thickness is coated with ITO (Indium Tin Oxide) by DC magnetron sputtering to a thickness of 1200Å. An electrode (9) with 640 of strips is formed with an excimer laser. (Fig. 1(a).) But in Fig. 1(a) only a few electrodes are described.

And as a second substrate (2) similarly, a sodalime glass substrate of 1.1mm thickness is coated with ITO by 1200Å and 400 of electrodes are formed with an excimer laser. (Not described.) The output energy of the excimer laser beam is 250mJ, the pulse width is 20 nanoseconds, the cross section of the beam is 15μm x 400mm and the repetition frequency is 10Hz.

Thus, ITO films are cut and then the edges of ITO films are cut again with the excimer laser. (Fig. 1(b).) The cross section of the excimer laser beam in this case is 30μm x 400mm and a mask covering the center portions of the substrate (the part of not cutting ITO) can prevent ITO from cutting. The other conditions are same as those of the above.

And then, the surfaces of the first and second substrate are coated with polyamic acid by the offset printing and they are heated in a clean oven at 350℃ for three hours to form polyimide thin films. The polyimide film on the first substrate (1) is given rubbing treatment with a cotton cloth and SiO_2 file praticles of 8μm diameter are dusted thereon as spacers. On the second substrate (2), an epoxy adhesive is print out with a screen printer. After the first and second substrates paste together, the opening, through which the liquid crystal material is injected by a known vacuum injection, is then sealed off by an adhesive cured by ultraviolet rays. In this way, a liquid crystal panel is completed.

Next is the explanation of manufacture of a substrate to mount IC chips for driving a liquid crystal.

A third substrte (3) is provided by depositing ITO films on a 1.1mm thick sodalime glass substrate of 50mm width and

270mm length and a wiring (19) is formed by photolithography. And the wiring is then coated with Ni and thereafter with Au by plating. This wiring includes a wiring to put signals in a semiconductor chip (5) (not described) and a wiring to contact output signals from a semiconductor chip (5) to a liquid crystal panel.

The semiconductor chip (5) for driving a liquid crystal, which Au bumps are formed in the part of pads, is connected. In this connecting method, an ultraviolet light curable adhesive is dripped onto the surface of the semiconductor chip by dispenser method and wirings and bumps are put together, and ultraviolet light is exposed under pressure of 95g per bump at 150℃ for three minutes. By this method, the required number of semiconductor chips and wirings can be connected with both the side of the common electrode and the side of the data electrode.

Then, a test regarding connection of semiconductor chips is given.

And then, in the all semiconductor chips disposed on the substrates, only chips that can be connected perfectly are connected with liquid crystal panels by the following means in the present embodiment; first, on the wiring formed in the part (4) that is the surface of the first substrate but is not corresponded with the second substrate of liquid crystal panels, ultraviolet light curable adhesive (8) in which a fine conductive particles (6) and particles (7) which is slightly smaller than that particles are mixed are coated by means of a dispenser. Then, the wiring of the part coated with the adhesive on liquid crystal panel and the wiring on the substrates mounted

semiconductor chips are aligned to each other, and exposed to ultraviolet light for three minutes under pressure of about $2.4kg/cm^2$. The particles (6) used in this embodiment are made from 7.5μm thick polystylene spheres plated with a 1000Å thick Au film. The particles (7) that is slightly smaller than the particles (6) are made from 5μm thick SiO_2 spheres. The weight proportion among the ultraviolet light curable adhesive (8), the conductive particles (6) and the fine particles (7) is 107:14:4.

After that, thermal shock tests at -30℃ and at 70℃ respectively for an hour are done and the inferior result is not obtained at all as well as the case immediately after connection.

In the case that the wiring of liquid crystal panels is connected with the wiring on the substrate mounted semiconductor chips, it is enough possible to use only conductive particles, but it is more reliable for connection to use two kinds of particles like the present embodiment.

The liquid crystal electro-optical device manufactured in the present embodiment is not needed the printed substrate of glass epoxy and is very light because semiconductor chips are mounted on the glass substrate, and further the substrate mounted semiconductor chips is different from the substrate consisted of liquid crystal panels, so that only the substrate connected with semiconductor chips perfectly can be connected with liquid crystal panels and the manufacturing yield is largely increased.

Further in the present embodiment, because only one point for connection is needed in connection of a wiring, the

manufacturing yield is more increased as well as process is more simplified as compared with the case used FPC.

Particularly in the present embodiment, the electrode of liquid crystal panels is manufactured by using an excimer laser and a liquid crystal panel whose interval of electrodes is very small is obtained.

Further in the present embodiment an excimer laser is exposed for two times, this can make ITO electrode thinner, where is connected with the substrate mounted semiconductor chips, and make an insulated resistance of adjacent electrodes large enough.

[EMBODIMENT 2]

A liquid crystal panel is manifactured.

First sodalime glass substrate (1) of 1.1mm thickness is coated with ITO (Indium Tin Oxide) films by DC magnetron sputtering to a thickness of 1200Å. An electrode (9) with 640 of strips is formed with an excimer laser. In the present embodiment the condition of Fig. 1(a) is sufficient. In the same way, second sodalime glass substrate (2) of 1.1mm thickness is coated with ITO films to a thickness of 1200Å and an electrode with 400 of strips is formed with an excimer laser. In this process, the condition that an excimer laser exposes is the same way as embodiment 1, that is, the energy of the excimer laser beam is 250mJ, the pulse width is 20 nanoseconds, the cross section of the beam is 15μm x 400mm and the repetition frequency is 10Hz.

And then, the surfaces of the first and second substrate are coated with polyamic acid by the offset printing and they

are heated in a clean oven at 350℃ for three hours to form polyimide thin films. The polyimide film on the first substrate (1) is given rubbing treatment with a cotton cloth and SiO_2 file praticles of 8μm diameter are dusted thereon as spacers. On the second substrate (2), an epoxy adhesive is print out with a screen printer. After the first and second substrates paste together, the opening, through which the liquid crystal material is injected by a known vacuum injection, is then sealed off by an adhesive cured by ultraviolet rays. In this way, a liquid crystal panel is completed.

Next is the explaination of manufacture of a substrate to mount IC chips for driving a liquid crystal.

A third substrte (3) is provided by depositing ITO films on a 1.1mm thick sodalime glass substrate of 50mm width and 270mm length and a wiring (19) is formed by photolithography. And the wiring is then coated with Ni and thereafter with Au by plating. This wiring includes a wiring to put signals in a semiconductor chip (5) (not described) and a wiring to contact output signals from a semiconductor chip (5) to a liquid crystal panel.

The semiconductor chip (5) for driving a liquid crystal, which Au bumps are formed in the part of pads, is connected. In this connecting method, an ultraviolet light curable adhesive is dripped onto the surface of the semiconductor chip by dispenser method and wirings and bumps are put together, and ultraviolet light is exposed under pressure of 95g per bump at 150℃ for three minutes. By this method, the required number of semiconductor chips and wirings can be connected with both the

side of the common electrode and the side of the data electrode.

Then, a test regarding connection of semiconductor chips is given.

And then, in the all semiconductor chips disposed on the substrates, only chips that can be connected perfectly are connected with liquid crystal panels by the following means in the present embodiment; first, on the wiring formed in the part (4) that is the surface of the first substrate but is not corresponded with the second substrate of liquid crystal panels, ultraviolet light curable adhesive (8) in which a fine conductive particles (6) and particles (7) which is slightly smaller than that particles are mixed are coated by means of a dispenser. Then, the wiring of the part coated with the adhesive on liquid crystal panel and the wiring on the substrates mounted semiconductor chips are aligned to each other, and exposed to ultraviolet light for three minutes under pressure of about 2.4kg/cm^2. The particles (6) used in this embodiment are made from 2.5μm thick polystylene spheres plated with a 1000Å thick Au film. The particles (7) that is slightly smaller than the particles (6) are made from 2μm thick SiO_2 spheres. The weight proportion among the ultraviolet light curable adhesive (8), the conductive particles (6) and the fine particles (7) is 98:13:3.

After that, thermal shock tests at -30℃ and at 70℃ respectively for an hour are done and the inferior result is not obtained at all as well as the case immediately after connection.

In the present embodiment, not only the result of embodiment 1 is naturally obtained but also process can get shorter than

the case of embodiment 1 because an excimer laser is exposed for one time in manufacturing an electrode of a liquid crystal panel. But in order to make an insulated resistance of adjacent electrodes large enough, the present embodiment use a rather smaller conductive particles than that of embodiment 1.

[EMBODIMENT 3]

In connecting liquid crystal panels with semiconductor chips manufactured in the same way as embodiment 1, a liquid crystal electro-optical device can be manufactured, which is mechanically much superior strength to that of embodiment 1, by fixing the substrate connected to the side of the common electrode of liquid crystal panels to the substrate connected to the side of the data electrode of liquid crystal panels in their intersection (10) by the means of a ultraviolet light curable adhesive as shown in Fig. 4.

Since the same level is formed with the substrate of the side of the common electrode and the substrate mounted semiconductor chips connected to the substrate of the side of the data electrode and the other hand the same level is formed with the substrate of the side of the data electrode and the substrate mounted semiconductor chips connected to the substrate of the side of the common electrode, they can be fixed to each other in the intersection (10) in the present embodiment. Thus, as shown in Fig. 5, a sheet of substrate (18) is attached to the one side substrate formed liquid crystal panels and the substrate mounted semiconductor chips astride the gap therebetween. As a result, the mechanical strength can increase

much more.

In Fig. 5, the substrate (18) is described only between the one side substrate of the two substrate mounted semiconductor chips and the substrate (1), but it is arranged in the same way between the other side substrate mounted semiconductor chips and the substrate (2).

The substrate (18) is for reinforcement of the part of connection of liquid crystal panels and the substrate mounted semiconductor chips, and its quality of the material is not specified. Also, its shape is not specified if it can perform a part in reinforcement.

[EFFECT]

As above-mentioned, by using the present invention, a liquid crystal electro-optical device can be manufactured, which is light and low-priced, which can obtain high contrast owing to large aperture ratio, with a high yield.

[BRIEF DESCRIPTION OF THE INVENTION]

Fig. 1 (a) and (b) show a shape of an electrode.

Fig. 2 shows a part of connection of a liquid crystal electro-optical device in section, in using the present invention.

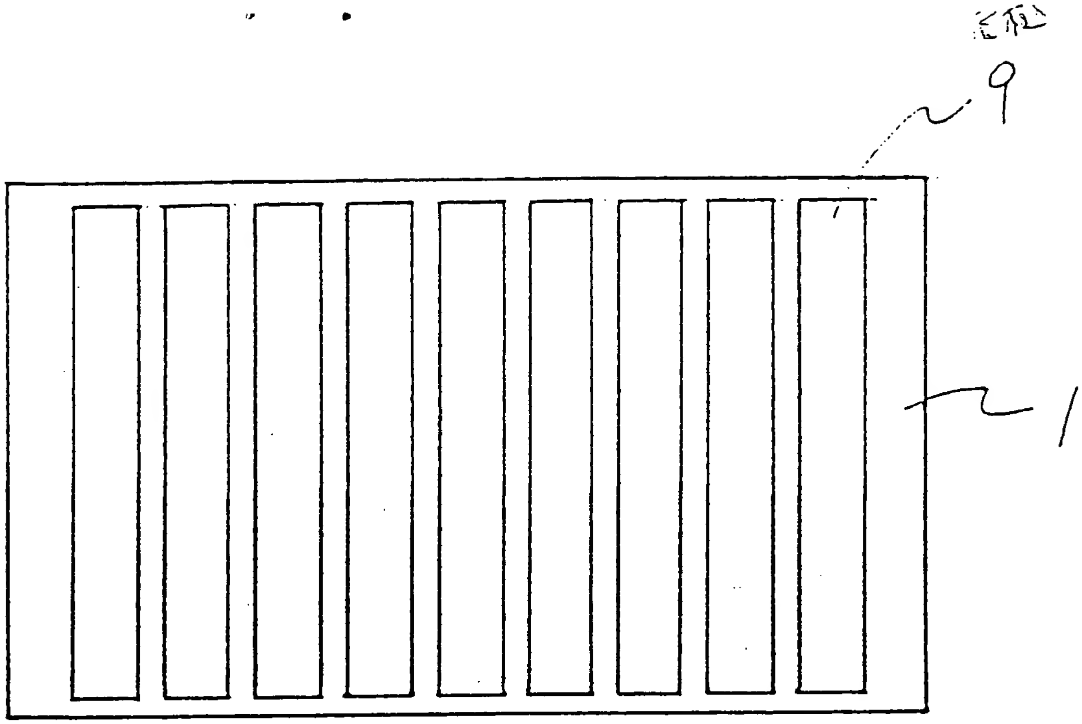
Fig. 3, 4 and 5 show a liquid crystal electro-optical device in section entirely, in using the present invention.

1, 2, 3	-----	A substrate
5	-----	A semiconductor chip
6	-----	A conductive particles
7	-----	A fine particles
8	-----	An ultraviolet light curable adhesive
11	-----	FPC

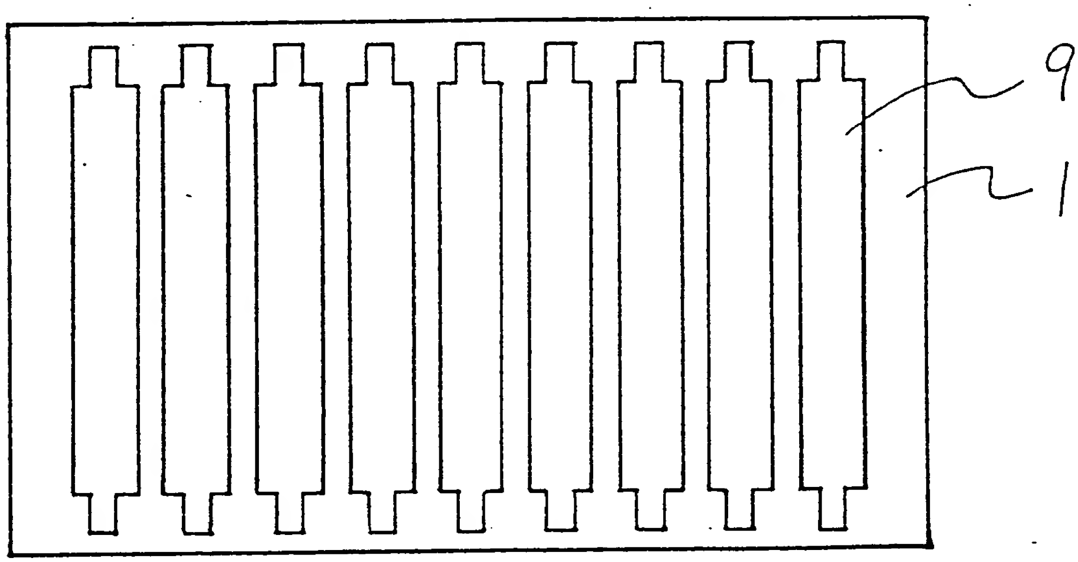
APPLICANT

Semiconductor Energy Laboratory Co., Ltd.

Representative Shunpei YAMAZAKI

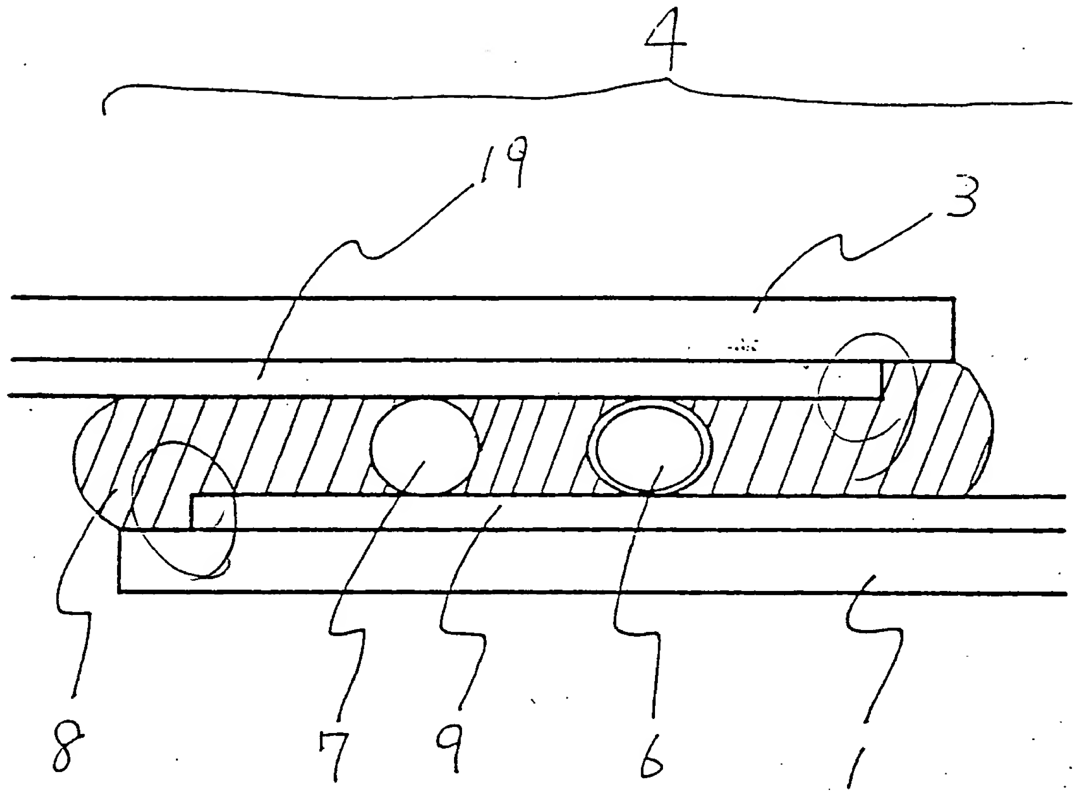


第 1 図 (a)



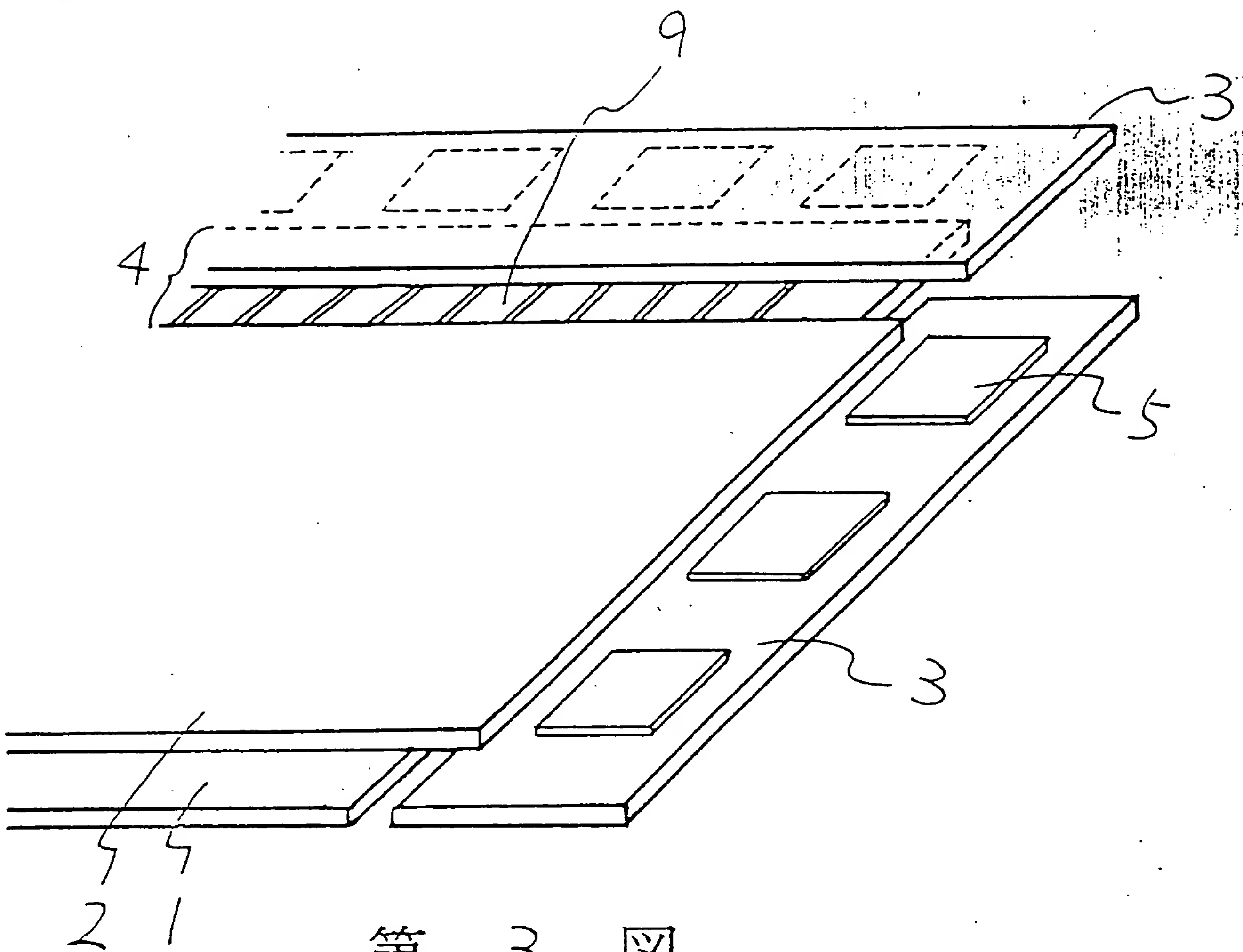
第 1 図 (b)

特許出願人
株式会社半導体エネルギー研究所
代表者 山﨑 舜 平



第 2 図

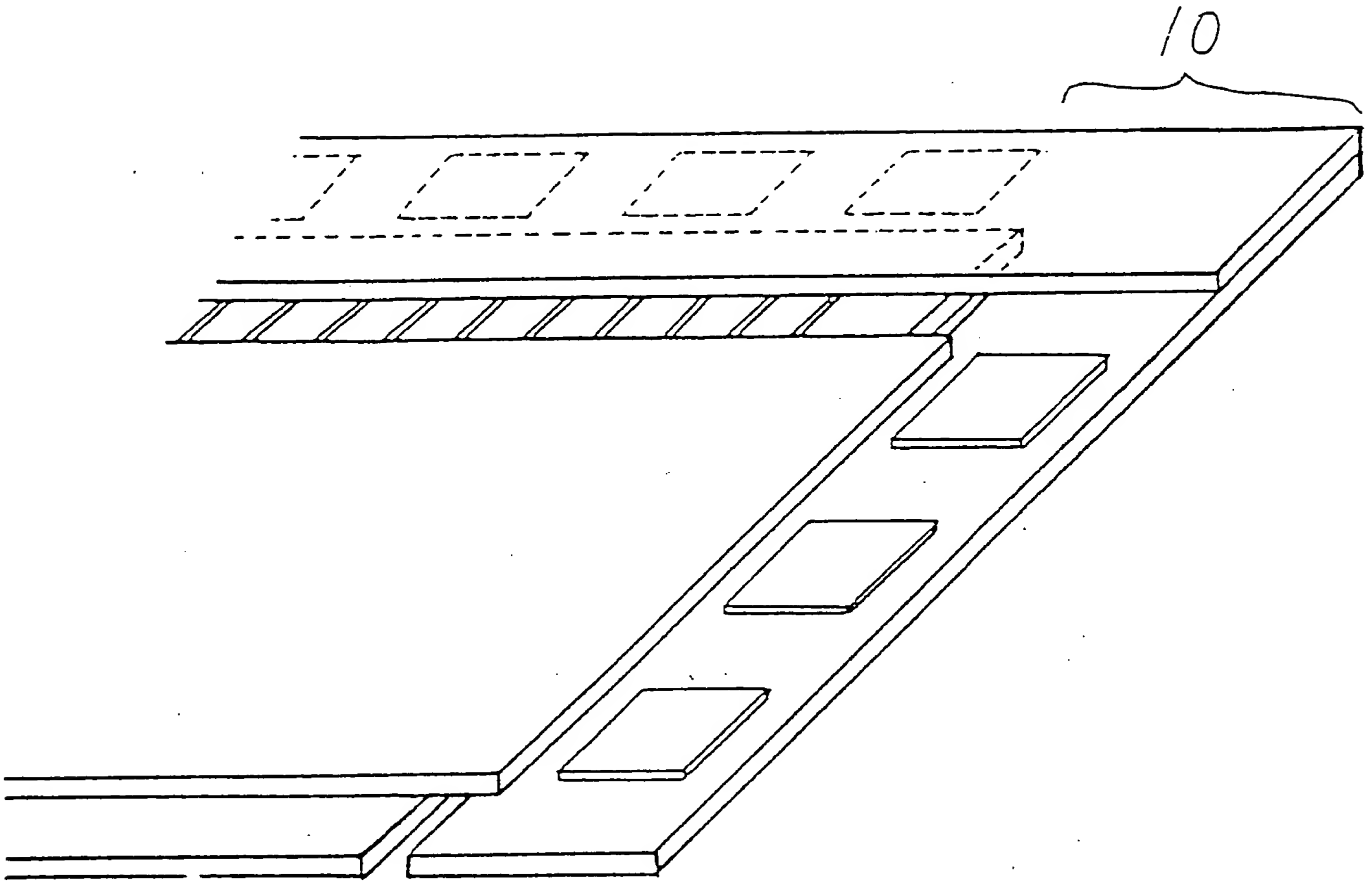
特許出願人
株式会社半導体エネルギー研究所
代表者　山　﨑　舜　平



第 3 図

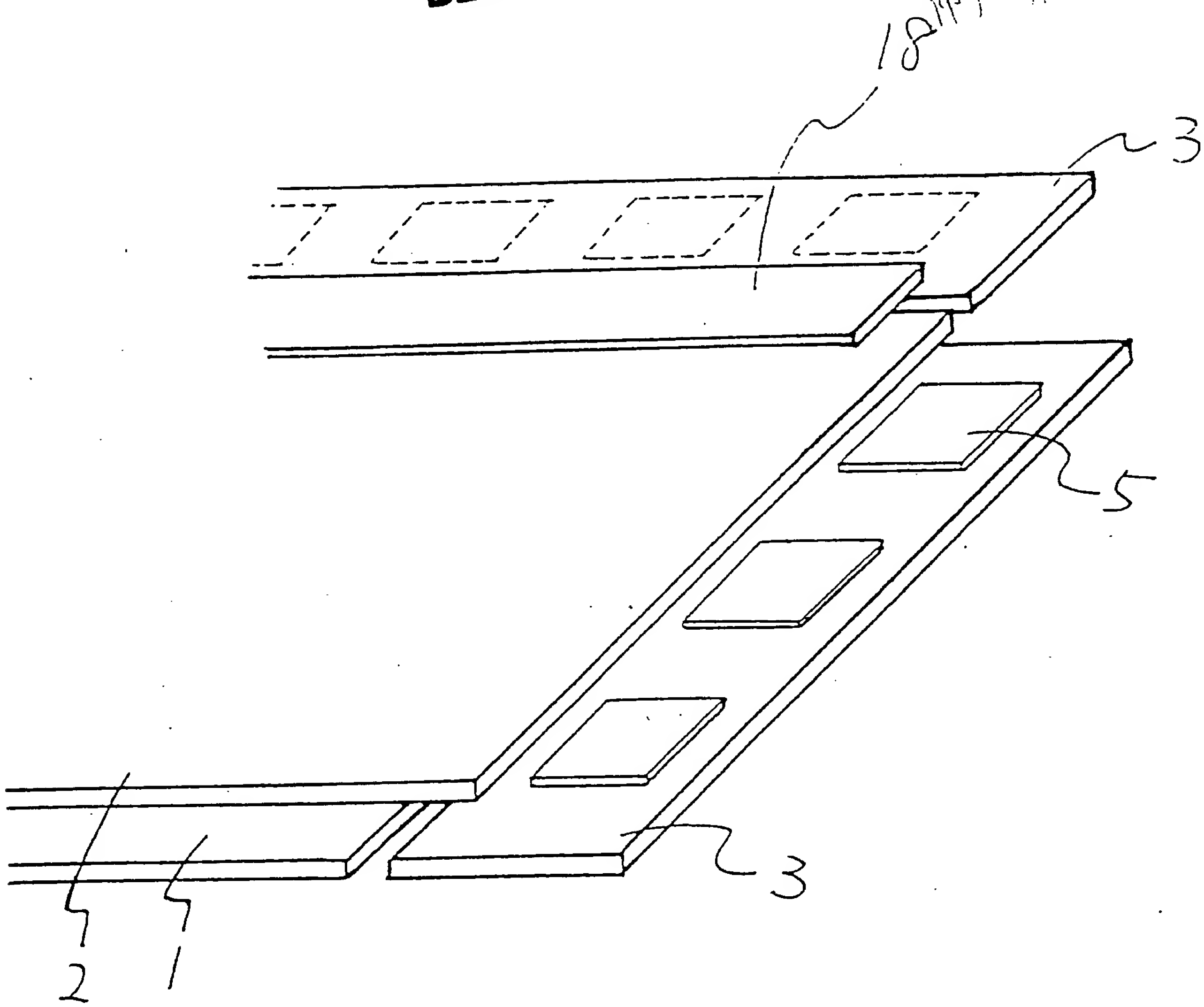
特許出願人
株式会社半導体エネルギー研究所
代表者　山　崎　舜　平

BEST AVAILABLE COPY



第 4 図

特許出願人
株式会社半導体エネルギー研究所
代表者　山崎舜平



第　5　図

特許出願人
株式会社半導体エネルギー研究所
代表者　山　崎　舜　平